

Larvae of Nymphulinae (Lepidoptera: Pyralidae) associated with *Hydrilla verticillata* (Hydrocharitaceae) in North Queensland

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Abstract

Australian Nymphulinae are a diverse group of moths with aquatic caterpillars that probably play an important role in determining the composition and abundance of aquatic macrophytes in Australian freshwater systems. Less than 10% of the nymphuline larvae in Australia have been described. As part of a project to develop biological control agents for hydrilla, *Hydrilla verticillata*, we encountered a variety of Nymphulinae larvae feeding on this and other aquatic plants. We illustrate, describe and provide a key to five species of Nymphulinae larvae (*Ambia ptyolycusalis* (Walker), *Parapoynx diminutalis* Snellen, *Hygraula nitens* Butler, *Margarosticha repitalis* (Warren) and *Theila siennata* (Warren)) that feed on hydrilla in North Queensland. Information on their host plants also is included. Our field research indicates that none of these species should be considered as potential biological control agents for hydrilla.

Key words *Ambia*, aquatic caterpillars, *Hygraula*, *Margarosticha*, *Parapoynx*, *Theila*.

INTRODUCTION

Worldwide, some 12 families of Lepidoptera have been reported to have aquatic larvae (Lange 1984). Aquatic larvae occur most commonly in the family Pyralidae, and members of the subfamily Nymphulinae are the best adapted for aquatic existence with all the immature stages (egg, larva and pupa) undergoing their entire development in the water (Lange 1984). Like their terrestrial counterparts, aquatic caterpillars can dramatically affect the density and composition of the hosts upon which they feed.

Common (1990) reported 60 species in 23 genera of Nymphulinae in Australia. However, Schaffer *et al.* (1996) reduced this number to 16 genera containing 47 species. While the assignments and identifications by Schaffer *et al.* (1996) are a great improvement over the 'old' names, they should be considered provisional until more is known about the larvae and the habits of Australian Nymphulinae.

The larvae of Australian Nymphulinae are poorly known. Common (1990) illustrated – but did not describe – the larva of *Hygraula nitens* Butler. We suspect that *H. nitens* belongs in the genus *Parapoynx* but we follow the Checklist of the Lepidoptera of Australia (Schaffer *et al.* 1996). Future revisions of Nymphulinae based on morphology of adults, larvae and biological information can resolve the correct position of

H. nitens. This appears to be the only species of Nymphulinae larvae from Australia to have been illustrated. However, larvae of four widely distributed Nymphulinae species whose range includes Australia were illustrated and described by Yoshiyasu (1985) from Japan. These include: *Parapoynx diminutalis* Snellen, *P. crisonalis* (Walker), *P. fluctuosalis* (Zeller) and the rice pest, *P. stagnalis* (Zeller).

Hydrilla, *Hydrilla verticillata* (Hydrocharitaceae), a submersed macrophyte native to Australia (Swarbrick *et al.* 1981) and to Asia and central Africa (Cook & Luond 1982), was imported to Florida, USA in the mid-1950s (Schmitz *et al.* 1990) and quickly became a weed there. Since then, it has spread throughout all the southern states and along the eastern seaboard of the USA (Steward *et al.* 1984). A recent analysis of distribution records of hydrilla in Asia indicates that its continued spread in North America is likely, and in the future, may infest Canada (Balciunas & Chen 1993). In surveys conducted in Australia from 1985 to 1989 to locate potential biological control agents for hydrilla, five species of Nymphulinae caterpillars were feeding on hydrilla (Balciunas & Center 1988; Balciunas *et al.* 1989). In 1992, one of us (DHH) spent 4 months in North Queensland collecting and studying the more promising of these nymphuline larvae (Habeck 1996). The descriptions and illustrations of the larvae of these hydrilla moths presented in this paper double the number of Australian Nymphulinae larvae which have been described.

Previous studies of closely related *Parapoynx* spp. larvae in Florida indicated that larvae could be identified on the basis of morphological characters and did not have to be reared (Habeck 1974).

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METHODS AND MATERIALS

Larvae were collected in various locations in Australia, but primarily in North Queensland, on hydrilla and other aquatic plants. Specimens were reared individually in one ounce (eight fluid drams US) plastic cups so adults and larvae could be associated. Once the association was made, larvae could be identified without rearing. Field-collected larvae of *Theila siennata*, *Ambia ptolycusalis* and *Margarosticha repitalis* were readily reared in one ounce plastic cups by changing water every other day and providing food.

Larval descriptions were prepared by using a dissecting microscope. Certain small parts (mandibles, labrum) were separated from the head and mounted on temporary slides. Nomenclature for chaetotaxy is that of Hinton (1946) as modified by Stehr (1987). Information on the biology and host plants of these five species is included. The names follow the catalogue of Australian Lepidoptera (Schaffer *et al.* 1996). Voucher specimens of larvae have been deposited in the Australian National Insect Collection, Canberra (ANIC), the US Museum of Natural History, Washington, DC, the Florida State Collection of Arthropods, Gainesville, Florida, USA, and in the collection of Dr Yataka Yoshiyasu, Kyoto Prefectural University, Kyoto, Japan, and the McGuire Center for Lepidoptera and Biodiversity, Gainesville, Florida, USA.

To provide a clearer picture of the geographical distribution of these five moth species, we also examined, on several occasions (most recently, on 2 March 1995), all the specimens of these species that were held at ANIC. We incorporate the ANIC label information into our discussions of the distribution of these moths.

SYSTEMATICS

The larvae of the five hydrilla-feeding caterpillars are easily distinguished from each other. Additional characteristics could have been added, but would only complicate and increase the length of each couplet. Therefore, only easily observed characters were used. It would be far more difficult to separate larvae of *P. diminutalis* and *H. nitens* from other *Paraponyx* species than from the other hydrilla feeders.

Key to mature larvae of Australian Nymphulinae attacking hydrilla

- | | | |
|----|---|---|
| 1 | Gills branched (cf. Fig. 1); in portable case; in still or slow-moving water | 2 |
| 1' | Gills unbranched; in non-portable shelters, in moving water only (Fig. 11) | 3 |
| 2 | Conspicuous brown spots around setae on head and most setae on pro- and mesothorax (Fig. 1) | |
| | <i>P. diminutalis</i> | |
| 2' | Without brown spots around setae on head and thorax (Fig. 6) | |
| | <i>H. nitens</i> | |
| 3 | Gills on prothorax; gills ventrally; anal shield setae subequal in length and thickness (Fig. 23) | |
| | <i>A. ptolycusalis</i> | |

- | | | |
|----|--|---|
| 3' | Without gills on prothorax or ventrally; anal shield setae unequal in length and thickness (Fig. 28) | 4 |
| 4 | Abdominal segments 3–6 each with three gill groups on each side; head prognathous (Fig. 17) | |
| | <i>M. repitalis</i> | |
| 4' | Abdominal segments 3–6 each with four gill groups on each side; head hypognathous (Fig. 11) | |
| | <i>T. siennata</i> | |

Paraponyx diminutalis Snellen (Figs 1–5)

Distinguishing characteristics: Gills branched (Fig. 1); a conspicuous brown spot around base of all setae and pores on head and prothorax and most setae and pores on meso- and metathorax. Maximum length: 14 mm; in a portable case.

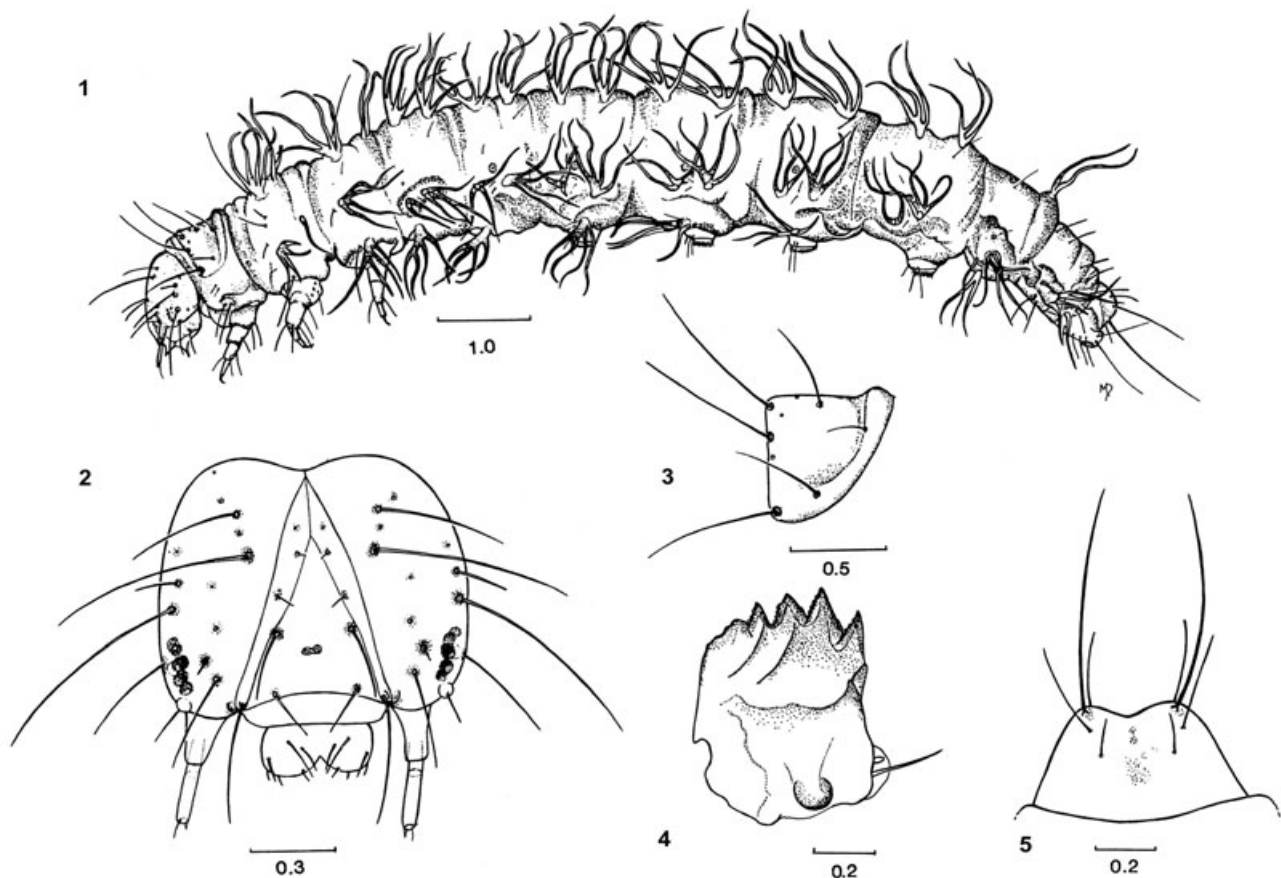
Colour: Head, prothoracic shield, crochets and sclerotised ring around prolegs pale yellowish-brown. Thoracic legs and anal shield light yellowish-brown. Body creamy-white. A conspicuous brown spot around base of all head, prothoracic and most meso- and metathoracic setae and pores.

Gills: Branched gills (Fig. 1) present on T2–3 and A1–9. Dorsal gills: 2 on T2–3 and A1–6, 1 on A7. None on A8–9. Lateral gills: 2 on T2 and A1–7; 1 on T2 and A8. Subventral gills: 1 on T2 and A1–6. Most gills with 4 branches, from 1/2 to 3/4 width of body.

Head: (Fig. 2). Maximum width 1.1 mm, hypognathous. Adfrontals extending nearly to vertical triangle. Clypeo-frons extending 0.87 of way to vertex. Seta P2 above frons; line through P1 setae slightly anterior to AF2 setae but posterior to AF puncture. AF2 setae below apex of frons. F1 setae above line through F punctures. AF1 setae nearer to F1 seta than to P1 seta. A2 seta posterior of and near A1 seta. A2 seta short, about 0.2 as long as A1 seta and 0.1 of A3 seta which is very near L1 seta. S2 seta 2× as long as S1 seta and 4× as long as S3 seta. Labral notch extending about 0.33 of way to base. Labrum with 6 unmodified setae per side. Mandible yellowish-brown with reddish brown teeth. Mandible with 5 teeth plus 2 on the outer ridge (Fig. 4). Condyle small. 6 stemmata represented by a dark area except stemma 6 inconspicuous; stemmata 3–5 close. Lens usually apparent on stemmata 1–5 with 3 and 4 larger than others.

Thorax: T1 with XD2 seta closer to XD1 seta than to SD1 seta (Fig. 3). Distance between XD1 and XD2 setae slightly more than between XD1 and D1 setae, directly posterior of XD1 seta. D2 seta on posterior roll of prothoracic shield. SD2 seta posterior-dorsal of SD1 seta. Lateral setae fine, short and without an obvious pinaculum, with L2 slightly more conspicuous. SV setae about equal in length, also without an obvious pinaculum. On T2 and T3, setae D1, D2, SD1 and SV1 easily located. Anterior dorsal gills arise ventro-posterior of D2 seta. Seta SD2 minute. L1 seta dorsal to and nearer L2 seta than to L3 seta I, L3 seta more dorsal and posterior. Coxae touching on all 3 segments.

Abdomen: Spiracles obvious on A2–4. Prolegs on A3–6 and 10 with uniserial, biordinal crochets in a circle. A10 circle incomplete posteriorly. Sclerotised ring around crochets. All



Figs 1–5. *Parapoynx diminutalis* Snellen: (1) mature larva, lateral view; (2) head; (3) prothoracic shield; (4) mandible; (5) anal plate.

setae inconspicuous. 2 L setae on A9. SV setae: 1 on A1, A8–9, 2 on A2, 7 and 3 on A3–6, those on A3–6 anterior to the crochets. Anal plate: SD1 only robust seta, twice as long as D2 seta (Fig. 5). SD2 seta more ventral and anterior. SD2 seta about equidistant between SD1 and D1 setae.

Distribution: We collected *P. diminutalis* larvae primarily in lentic habitats around Cairns. Most of the 85 adults at ANIC were from North Queensland and the Top End portion of Northern Territory. The most southerly specimens were from Millstream, Western Australia, Brisbane, Queensland, and Tebulem, New South Wales.

***Hygraula nitens* Butler (Figs 6–10)**

Distinguishing characteristics: Gills branched; setae on head and thorax without conspicuous brown spots around base. Maximum length: 12 mm; in a portable case of plant parts (Fig. 6).

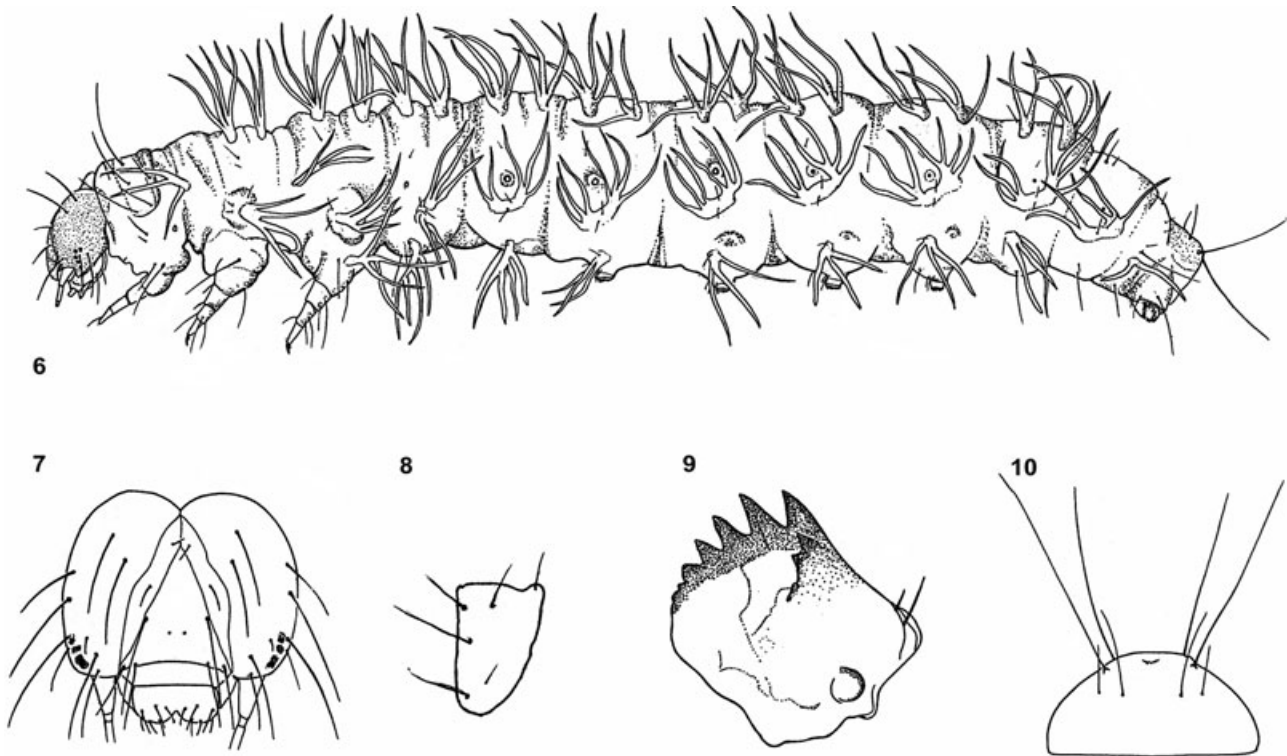
Colour: Head, prothoracic shield, claws, crochets, and sclerotised ring around prolegs pale yellowish-brown, anal shield very pale yellowish-brown. Body creamy-white.

Gills: Branched gills (Fig. 6) present on T2–3 and A1–9. Dorsal gills: 2 on T2–3 and A1–7, none on A8–9. Subdorsal gills: 1 on T2–3; Lateral gills: 1 on T2–3, 2 on A1–8; Subventral gills: 1 on T3, A1–9. Most gills 1/2 to 3/4 width of body and with 3 branches.

Head: (Fig. 7). Maximum width 1.1 mm, hypognathous. Adfrontals extending to vertical triangle. Clypeofrons extending 70% of way to vertex. Seta P2 above frons; line through P1 setae slightly anterior of AF2 setae. P1 seta slightly nearer to seta AF1 than to seta P2. AF2 seta at or above frons apex. F1 setae above line through F punctures. A2 seta posterior of and near A1 seta. A2 seta short and distant from A3 near A3 seta. Labrum with 6 unmodified setae; labral notch approximately 90° and extending 1/3 the width of the labrum. 6 stemmata represented by a dark area except stemma 1 inconspicuous. Mandible as in Fig. 9 with 6 teeth.

Thorax: (Fig. 8). T1 with XD2 seta slightly nearer to XD1 seta than to SD1 seta. Distance between XD1 and XD2 seta and XD1 and D1 seta subequal. D2 seta fine, located on posterior roll of T1 shield. SD2 seta posterior and dorsal of SD1 seta. Lateral setae fine without an obvious pinaculum. SV setae about equal in length, also without an obvious pinaculum. D1 and D2 setae adjacent and mesad of anterior dorsal gill on T2–3. SD1 seta distinctly visible on T2–3. L1 and L2 setae inconspicuous and adjacent on T2–3. Coxae of T1–3 touching, nearly touching or separated by less than half the coxal diameter, respectively.

Abdomen: Spiracles present on A2–4, non-functional spiracles on A5–6. Prolegs on A3–6 and 10 with uniserial, biordinal crochets in a circle, incomplete posteriorly on A10. Sclerotised ring around crochets. Most setae inconspicuous. 2 L setae on



Figs 6–10. *Hygraula nitens* Butler: (6) mature larva, lateral view; (7) head; (8) prothoracic shield; (9) mandible; (10) anal plate.

A9. SV setae: 1 on A1, 7–9, 2 on A2, 3 on A3–6. Anal plate (Fig. 10): FD1 and SD1 setae adjacent and subequal in length and strength. D1 and D2 setae fine, short and almost in transverse row.

Distribution: Besides many of our lentic sites in Queensland, we collected the larvae of *H. nitens* in Northern Territory and New South Wales. With approximately 200 adult specimens, this is the most abundant nymphuline in the ANIC collection. It has been recorded from every state, including Tasmania, as well as Australian Capital Territory.

***Theila siennata* (Warren) (Figs 11–16)**

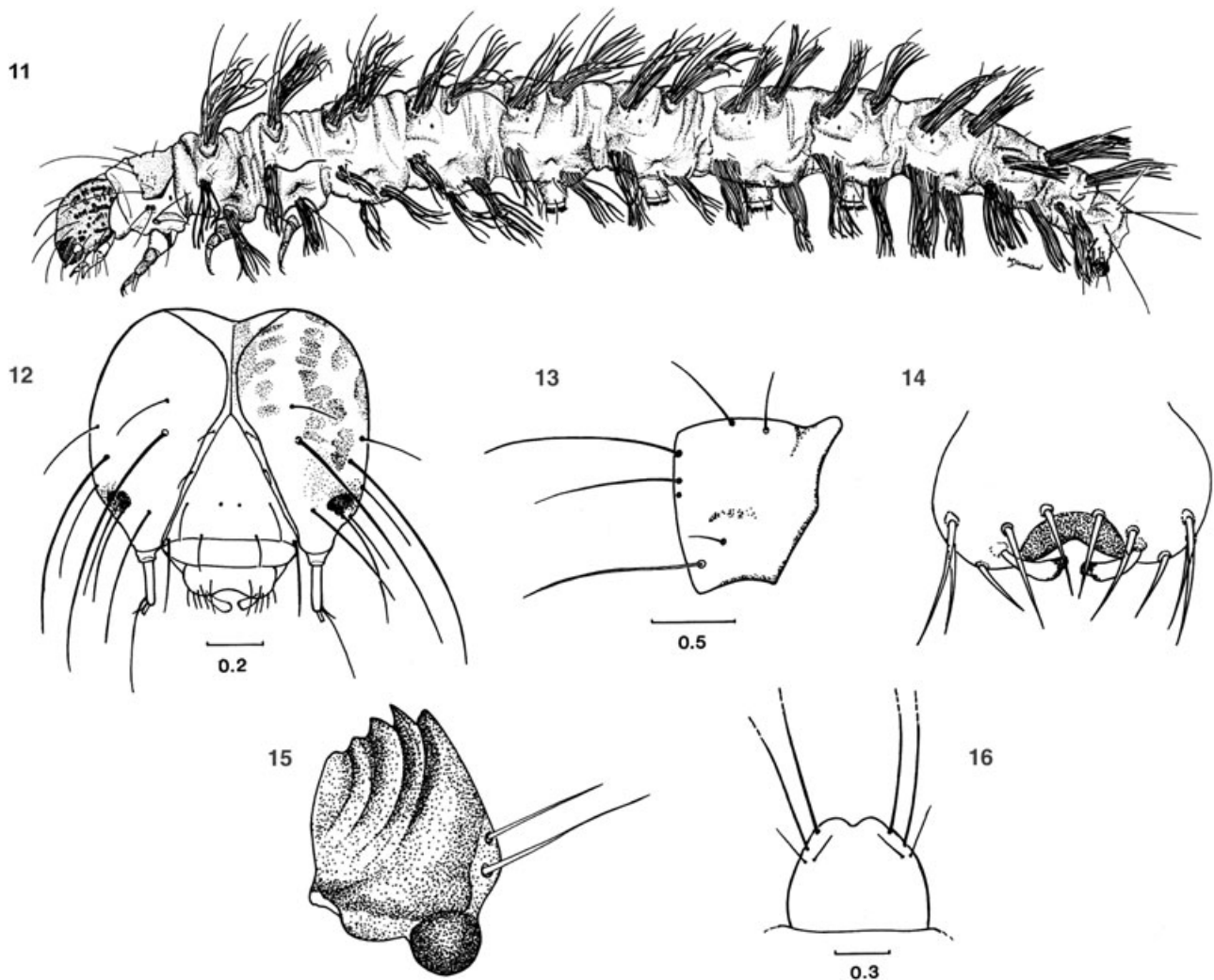
Distinguishing characteristics: Head hypognathous. Adfrontals extending 85% to vertical triangle. Clypeofrons extending 70% to vertical triangle. Prothoracic shield with an indistinct transverse furrow near posterior margin. XD1 and XD2 setae 0.33× as far apart as XD2 and SD1 setae. D1 and D2 setae posterior-dorsad of XD1 seta. Gill groups: 3 on T2–3, 5 on A1–2, 4 on A3–8, 2 on A9. Maximum length: 25 mm. Usually in a silken tube shelter covered with plant parts; sometimes free. **Colour:** Head light brown with dark markings (Fig. 12). Body light brown but appearing darker due to dense covering of stellate asperities. Prothoracic shield, leg segments brown. Crochets and sclerotised ring around crochets dark brown to black.

Gills: Unbranched, filamentous in groups (Fig. 11): 3 on T2–3, 5 on A1–2, 4 on A3–8, 2 on A9. Maximum length of gills: about 0.5–0.6 body width.

Head: (Fig. 12). Maximum width 2 mm, hypognathous. Line through P1 setae near or through AF2 setae. Line through P2 setae above AF2 setae and above apex of frons. Line through F1 setae through or slightly below F punctures. A1 seta almost directly anterior of A2 seta; distance between A1 and A2 setae greater than distance between A3 and L1 setae. S2 seta more than 2× longer than S1 seta and less than 2× as long as S3 seta. Stemmata 3 and 4 adjacent, stemma 6 barely discernible. Labrum notched, seta M3 modified into scalelike scraping structure (Fig. 14). Mandible (Fig. 15) with 3 ventral pointed teeth and 2 obtuse dorsal teeth; all teeth with ental ridges, but with 2, 3 and 5 (starting dorsally) especially strong.

Thorax: Conspicuous shield on T1 with an indistinct transverse furrow near posterior margin (Fig. 13). XD1 and XD2 setae about 0.33× as far apart as XD2 and SD1 setae. D1 and D2 setae posterior-dorsad of XD1 seta. SD2 seta posterior and slightly dorsad of SD1 seta. 2 L setae and 2 SV setae conspicuous. D2 setae on T2–3, short and inconspicuous. L1 and L2 setae close together, very fine. SD1 and SV setae in gill groups. Coxae touching on T1; T3 coxae separated most but by less than 0.25 width of coxa.

Abdomen: Spiracles on A2–4. D1 setae small, D2, SD1, L1 and SV setae in gill groups. SV setae: 1 on A1, 7–9, 2 on A2 and 3 on A3–6. L3 seta in front of SV gill group. 2 L setae on A9. V1 on A3–6 near circular ring, and slightly posterior of a line going through the middle of prolegs. Prolegs on A3–6 with uniserial, triordinal crochets in a circle. Sclerotised ring around crochets. A10 crochets triordinal in a transverse row. Anal shield (Fig. 16) undifferentiated. SD1 and D2 setae



Figs 11–16. *Theila siennata* (Warren): (11) mature larva, lateral view; (12) head; (13) prothoracic shield; (14) labrum; (15) mandible; (16) anal plate.

approximately equal in length and robustness. D1 and SD2 setae finer and equal in length.

Distribution: We collected all our larvae of *T. siennata* in streams within 150 km of Cairns. Many of the specimens at ANIC are from around Cooktown, and a few from the Top End portion of Northern Territory. Interestingly, the type specimen was from considerably further south, for example, Mackay, Queensland.

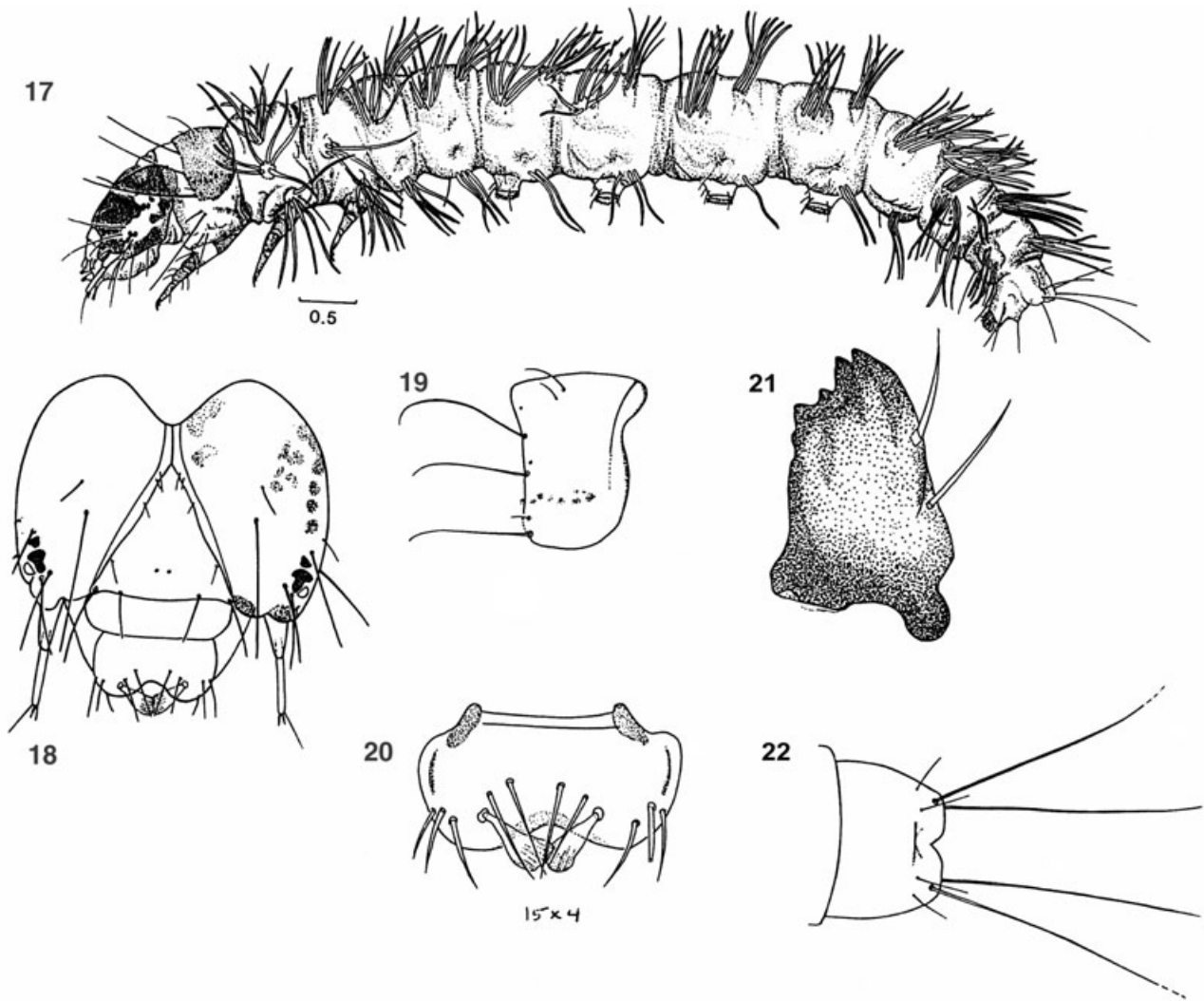
***Margarosticha repitalis* (Warren) (Figs 17–22)**

Distinguishing characteristics: Prognathous head, adfrontals extending to vertex. Prothoracic shield with setae D1 and D2 dorso-posterior of XD1 seta and SD2 seta almost dorsad of SD1 seta. With 3 gill groups on T2–3 and A1–8 and 2 on A9 (Fig. 17). Maximum length: 20 mm. In an elongate shelter made of 2 leaves or 1 leaf usually covered with algae filaments.

Colour: Head yellowish-brown with a lighter genal area extending to stemmata. Body light brown. Prothoracic shield distinct, slightly darker. Anal shield undifferentiated. Crochets, leg segments, claws, and sclerotised ring around crochets dark brown.

Gills: Unbranched filamentous gills in groups (Fig. 17). T2–3 and A1–8 with 3 gill groups. A9 with 2 gill groups. Gill groups located at SD, L1 +2 and SV setal positions on T2–3 and at D2, L1 +2 and L3 setal positions on A1–8. Longest gills about 67% of body width.

Head: (Fig. 18). Maximum width: 1.95 mm; prognathous. Adfrontals extending to vertical triangle. Clypeofrons extending about 85% distance to vertical triangle. P1 and P2 setae at about level of AF1 and AF2 setae, respectively. AF2 setae below frons apex and adjacent to AF puncture. F1 setae at or slightly above level of F punctures. A1 seta anterior of and as far from A2 seta as A3 seta is from L1 seta. Area between P1 seta and A1 seta, extending laterally almost to A3 seta and posteriorly slightly behind a line from L1 seta to P1 seta, shagreened. Distance between S3 and S2 setae about 4× distance between S1 and S2 setae. S2 seta nearly 2× as long as S3 seta and more than 2× length of S1 seta. Stemmata 3 and 4 touching, 6 inconspicuous. Labrum with a shallow notch, seta M3 modified into a scale-like scraping structure (Fig. 20). Mandible with 4 teeth each with an ental ridge (Fig. 21).



Figs 17–22. *Margarosticha repititalis* (Warren): (17) mature larva, lateral view; (18) head; (19) prothoracic shield; (20) labrum; (21) mandible; (22) anal plate.

Thorax: T1 with XD2 seta about equidistant between XD1 and SD1 setae (Fig. 18). D1 and D2 setae posterior-dorsad of XD1 seta and further from XD1 seta than XD2 seta. SD2 seta almost dorsad of SD1 seta. L1 setae about 2× longer than L2 seta. SV1 and SV2 setae about equal length. Setae D2, SD1 and SV1 on T2 and T3 conspicuous but other setae minute and difficult to see. L3 seta may be lacking. Coxae of T1 touching except anteriorly. T2 coxae separated by about width of coxal base and T3 coxae slightly further apart.

Abdomen: Spiracles on A2–4. Prolegs on A3–6, with uniseriate, irregularly triordinal crochets anteriorly, but generally biordinal posteriorly. Sclerotised ring around crochets. Crochets on A10 irregularly triordinal. D1 setae minute on A1–9. 2 L setae on A9. Setae L1 and L2 minute, close together, the more dorsal 1 hair-like and about 2× as long as the ventral 1 which has a conspicuous peritreme. L3 seta in front of gill group. SV setae: 1 on A1, 7–9, 2 on A2, 3 on A3–6. Anal plate with SD1 and D2 setae about same length and equally robust (Fig. 22). D1 seta and SD1 seta much finer and about 0.33×

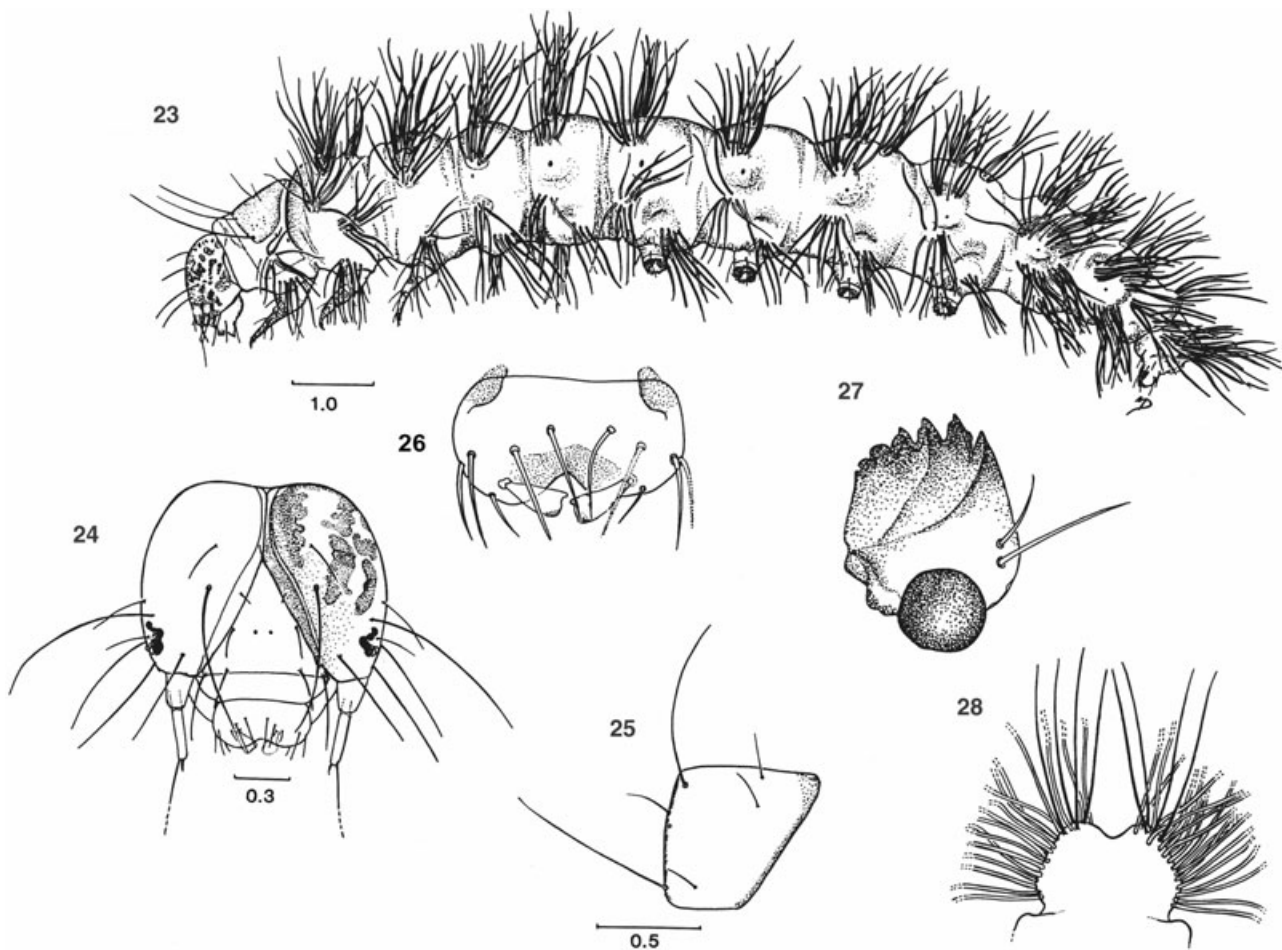
length of SD1 and D2 setae. SD2 seta slightly posterior of D1 seta.

Distribution: We collected the larvae of *M. repititalis* only in streams in the Mareeba/Cairns region. ANIC has specimens from as far south as Gympie in Queensland, as well as the northern portion of the Northern Territory and Western Australia, and as far south as Millstream (21.35°S).

***Ambia ptolycusalis* (Walker) (Figs 23–28)**

Distinguishing characteristics: Gills on T1. Mid-ventral gills on T2–3, A1–2 and occasionally single or double filaments mid-ventrally on A3–6. Gill filaments forming fan-like appearance on A8–10 (especially when viewed dorsally) (Fig. 28). Anal plate with 8 long subequal setae. Very large mandibular condyle (Fig. 21). Maximum length: 16 mm. In a shelter attached to plants.

Colour: Head pale yellowish-brown with prominent dark markings extending anteriorly from vertex (Fig. 24). A light brown genal stripe extending to stemmatal area. Prothoracic



Figs 23–28. *Ambia ptolycusalis* (Walker): (23) mature larva, lateral view; (24) head; (25) prothoracic shield; (26) labrum; (27) mandible; (28) anal plate.

shield yellowish-brown with a few darker spots. Leg segments, crochets and circular ring around crochets brown.

Gills: Numerous, unbranched filamentous gills in groups (Fig. 23). 2 T1 gill groups: the larger group posterior to the lateral setae and the smaller group ventral-posterior to the SV setae. T2 with 6 gill groups on each side plus a mid-ventral group behind coxae and near posterior margin. Other gill groups include 2 small dorsal groups, anterior 1 around D1 + D2 setae, a subdorsal group around SD setae, 2 lateral groups, the largest anterior and around 2 L setae, the lower gill group surrounding a single SV seta. T3 with 4 gill groups on each side and 2 mid-ventral groups of which the posterior 1 is as on T2, the anterior group is between the coxae and slightly anterior of a line drawn through the middle of the coxae. Other gill groups as on T2, except dorsal posterior group and lower lateral group are absent. A1–2 with dorsal, subdorsal, 2 L and SV gill groups (may be absent or reduced to 1 or 2 filaments) and a mid-ventral gill group (may be absent on A1). A 2nd dorsal gill group (1–4 filaments) often present on A1 and A4, but usually absent on A2–3. A5–6 with 2 dorsal gill groups associated with D1 and D2 setae, respectively, a subdorsal gill group surrounding SD setae, 1 lateral group on A3–5 but A6 with an additional smaller posterior gill group.

A subventral gill group dorso-posterior of the prolegs. Single or double gill filaments may occur mid-ventrally behind the prolegs. A7 similar to A6 but with the SD group extending posteriorly and without mid-ventral gills. A8 with posterior dorsal gill group. SD gill group elongate extending anterior to posterior over most of the segment. L gill groups smaller, V and SV gill group absent. A9 with posterior dorsal gill group. SD group large and on a lobe-like projection across segment. A10 with lateral gills on posterior portion. Gills longest on A10, as long as body width.

Head: (Fig. 24). Maximum width: 1.45 mm; hypognathous. Adfrontals extending about 75% of way to vertical triangle. Clypeofrons extending 60% to vertical triangle. Seta P2 at level of seta AF2. Line through P1 setae would pass midway between apices of frons and adfrontals. AF2 setae midway between apices of frons and adfrontals. F1 setae above line through F punctures. A2 seta lateral of and close to A1 seta. A2 seta very short, less than 20% length of A1 and A3 setae. A3 seta near L1 seta. S2 seta nearly 2× as long as S3 seta which is about 2× as long as S1 seta. Labral notch extending about 30% to base. Labrum with 6 setae, M3 modified into scalelike, scraping structure (Fig. 26). Mandibles yellowish-brown, dark at condyle with 6 teeth along margin (Fig. 27).

1st, 3rd and 4th teeth with ridges adorally. Condyle very large. Stemmata 3 and 5 larger than others. 3 and 4 appressed. Most of posterior margin of head dorsal from genal notch bordered in dark brown or black.

Thorax: Distance between XD1 and XD2 setae slightly more than 50% the distance between XD2 and SD1 setae. D1 and D2 setae dorso-posterior to XD1 and XD2 setae, respectively, and with D2 seta much nearer to posterior margin of T1 shield than to anterior margin. SD2 seta dorso-posterior to SD1 seta. L setae separate from T1 shield, L1 seta much longer and slightly posterior and dorsal of L2 seta. SV setae (2) subequal in length. T1 coxae touching, T2 coxae about 1 half as far apart as T3 coxae.

Abdomen: SV setae: 1 on A1, 7–9 on A2, 3 on A3–6. D2 setae absent on A1–6, present and larger on A7–9 than D1 seta. A2–4 with prominent spiracles. A3–6 with prolegs with biordinal brown crochets in a circle. Sclerotised ring around crochets sometimes incomplete posteriorly. SV setae on A7 about 2× as far apart as SV setae on A8 and A9 with 2 L setae. Anal plate undifferentiated, bilobed, each lobe with 4 long subequal (stoutness and length) setae (Fig. 28).

Distribution: The larvae of *A. ptolycusalis* were restricted to streams in North Queensland, and we collected them from Ingham to Daintree. They were especially abundant at Freshwater River near Cairns. Most of the 22 specimens of this moth at ANIC also were from this region, but a half dozen were collected in the vicinity of Cooktown.

DISCUSSION

Adults of all five species of aquatic moths are relatively brightly coloured and distinctly marked. The adults of *T. siennata* and *P. diminutalis* are sexually dimorphic and fairly easy to separate. The larvae also are easily separated. *Parapoynx diminutalis* and *H. nitens* are distinguished from the other three species by the presence of branched gills and body colour. The conspicuous brown spots around the base of the setae on the head and most setae on the dorsal and lateral aspects of the pro- and mesothorax of *P. diminutalis* separate it from *H. nitens* which lacks the brown spots. The larvae of *P. diminutalis* and *P. nitens* are creamy-white, while the larvae of the other three species are dingy greyish to brown.

Ambia ptolycusalis also is easily separated by the presence of gills on the prothorax and ventrally on the meso- and metathorax and abdominal segments 1–2 and sometimes on abdominal segments 3–6. In addition, the lateral gill groups on abdominal segments A8, A9 and A10 form a fan-like posterior when viewed dorsally or ventrally. This is similar to the fan-like gills found on *Eoparargyractis* species in North America. Another distinguishing character of *A. ptolycusalis* is the very large condyle on the mandible.

The larvae of *T. siennata* and *M. repititalis* are superficially similar. They can be separated by the number of gill groups on abdominal segments 3–6. *Margarosticha repititalis* has three while *T. siennata* has four. The head is prognathous in *M. repititalis* and hypognathous in *T. siennata*.

Host plants

Theila siennata larvae were collected from 12 plant species (Table 1). *Vallisneria spiralis*, *Blyxa octandra*, *H. verticillata* and *Ottelia alismoides* (all Hydrocharitaceae) were among the plant species on which *T. siennata* was collected. The first three genera, *Vallisneria*, *Blyxa* and *Hydrilla*, were fairly common, but *Ottelia* was not. *Ambia ptolycusalis* and *M. repititalis* also were common on the first three plants. *Parapoynx diminutalis* was found primarily only on hydrilla, although some *P. diminutalis* larvae and pupae were found on *Nymphoides indica* (Nymphaeaceae), but this was only where the hydrilla and *Nymphoides* were growing together. The larvae were probably seeking pupation sites since the pupal cases usually were constructed with hydrilla leaves and leaf fragments. Although *P. diminutalis* was the most host-specific, it is adventive in the USA (Del Fosse *et al.* 1976) and is now widespread in Florida (Balciunas & Habeck 1981), therefore no longer a candidate for importing into quarantine. In laboratory studies, *P. diminutalis* developed on 14 plant species in 13 genera but preferred hydrilla in choice tests (Buckingham & Bennett 1989). *Theila siennata* also was found on *Polygonum* (Polygonaceae), *Salvinia molesta* (Salviniaceae), *Aponogeton bullosus* (Aponogetonaceae), *Callitriche* (Callitricheaceae), an unidentified species of Apiaceae, as well as in the water among the live roots of grasses and trees growing on the stream margin. The unidentified Apiaceae also harboured larvae of *A. ptolycusalis* and *M. repititalis*. On one occasion, a *T. siennata* moth emerged from a cocoon collected from a submerged rock with no plants nearby.

Of the five Australian aquatic moths associated with hydrilla, *T. siennata* has the least restrictive host range (Table 1). It was collected from 12 species plus tree roots. *Ambia ptolycusalis*, the most host-specific of the three non-*Parapoynx* species, was found on nine plant species. *Margarosticha repititalis* was found on 11 plant species but since it was more common on *Vallisneria* and *Blyxa* than on hydrilla, it is no longer considered as a potential biological control agent.

Similarly, larvae of *Parapoynx stratiotata* (Linnaeus) tested for host-specificity to Eurasian watermilfoil *Myriophyllum spicatum* developed on many species of plants in laboratory studies, but were found almost exclusively on *Myriophyllum* spp. in the field (Habeck 1982). This indicates the importance of determining host plants in the field rather than relying on laboratory tests alone.

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Table 1 Plant species on which hydrilla-feeding aquatic caterpillars were found in the field

Family genus and species	<i>Parapoynx diminutalis</i>	<i>Hygraulis nitens</i>	<i>Theila siennata</i>	<i>Ambia ptolycusalis</i>	<i>Margarosticha repitalis</i>
Hydrocharitaceae					
<i>Blyxa octandra</i>			x	x	x
<i>Hydrilla verticillata</i>	x	x	x	x	x
<i>Vallisneria spiralis</i>			x	x	x
<i>Ottelia alismoides</i>			x		
Nymphaeaceae					
<i>Nymphoides indica</i>	x		x		
Najadaceae					
<i>Najas tenuifolia</i>				x	
Haloragaceae					
<i>Myriophyllum verrucosum</i>			x		
<i>M. trachycarpus</i>			x	x	x
Cabombaceae					
<i>Cabomba caroliniana</i>					x
Potamogetonaceae					
<i>Potamogeton tricarlinatus</i>				x	
<i>Potamogeton javonicus</i>					x
<i>Potamogeton crispus</i>		†			
Salviniaceae					
<i>Salvinia molesta</i>			x		
Polygonaceae					
<i>Polygonum</i> sp.			x		
Apiaceae					
<i>Unidentified</i> sp.			x	x	x
Callitricheaceae					
<i>Callitriche</i> sp.			x		
Aponogetonaceae					
<i>Aponogeton bullosus</i>			x		
Zosteraceae					
<i>Zostera</i> sp.		†			

†Records from Common (1990).

tries botanists Dr John Nelyar and Dr John Clarkson identified unknown plant species. Reviews by Dr J Cuda and Ms Susan Wineriter greatly improved the manuscript. Approved for publication as Florida Agricultural Experiment Station Journal Series No. R-10538.

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